Light and Lighting

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Registration of Lighting Engineers

AT the I.E.S Annual Meeting on May 13 a momentous departure was recorded — the formation, from amongst members of the Illuminating Engineering Society, of a "Register of Lighting Engineers."

We say momentous—for it is the first time that the Society has ventured to frame conditions for the award of what is substantially a professional distinction.

The Council, in taking this bold step, has, however, the evident support of I.E.S. members, by whom the need for some "hall mark" identifying those with expert knowledge of illumination has long been felt.

It will be observed, too, that this procedure does not prejudice the wide and impartial position of the Society as a cultural body; for what is proposed is a distinction, not a condition of membership. It still remains possible for anyone interested in illumination to join the Society and to enjoy all the privileges of membership as its Articles prescribe.

I.E.S. Annual Meeting

In our next issue we hope to comment more fully on the I.E.S. annual meeting, and on the annual dinner—the first held since the outbreak of war in 1939—which followed it.

In some ways it marked the termination of an era, the long period during which Mr. J. S. Dow acted as hon. secretary, and the initiation of what should prove a period of still greater prosperity. The transition has been achieved with exemplary smoothness, and the Society has been indeed fortunate in inducing Mr. H. C. Weston, one of its past presidents, to shoulder the task of honorary secretary.

In the meantime the Society has hit two targets which it set before it some years ago, but hardly expected to reach so soon—a total membership exceeding 2,000, and an annual income from subscriptions well over the £5,000 mark. This is roughly equivalent to two-fifths of the total membership and income of the American I.E.S. This has already made possible an increase in staff which should enable headquarters to deal efficiently with the greatly increased volume of routine work, as well as paving the way for new developments.

We refer elsewhere to another important departure, the proposed formation of a Register of Lighting Engineers, which members have now sanctioned. This should come into being in the near future, though doubtless there are still some details of organisation to be completed.

Following the annual general meeting there was a sessional meeting at which an address on "International Relations in Illuminating Engineering" was delivered by Dr. N. S. Halbertsma, President of the International Commission on Illumination.

At the annual dinner, which took place on the evening of May 14, the toast of the Society was proposed by Lord Marley (Chairman of the Colour and Lighting in Industry Council) to which the President responded; whilst Dr. Charles Hill (Secretary of the British Medical Association) responded to the toast of "The Guests," proposed by Mr. J. G. Holmes.

I.E.S. Presidential Visits to Leeds and Sheffield

The round of Presidential visits to I.E.S. Centres was completed last month when, on successive evenings, the address was given in Sheffield and Leeds, good attendances being secured on both occasions. The President (Mr. J. S. Dow) was accompanied on this occasion by the assistant secretary, Mr. G. F. Cole. Both were invited to attend the Council Meetings preceding the General Meetings, which were followed by dinner, well supported by leading officers and members of Committee. A pleasant feature at Sheffield was the presentation to the Chairman, Dr. A. J. Holland, who is taking up an appointment in Birmingham. The visits were timely in view of the proposal to hold a special "Summer Meeting" in Harrogate in May, 1948—the offer by the Leeds Centre to organise such a gathering before the war being now revived. This initial meeting should be followed by others, held in turn in each of the I.E.S. areas.

Public Lighting in Sheffield

Last month we referred to some street lighting problems in Glasgow. The writer had recently a similar opportunity of discussing with Mr. J. F. Colquhoun, the public lighting engineer in Sheffield, some of his experiences in these difficult times. Generally speaking "common stair" lighting, such an important feature in Glasgow, is not the concern of the local authority in Sheffield, though there are certain instances in which such lights are maintained by special arrangement. On the whole it seemed that service is remarkably well maintained, difficulties arising from shortage of material being successfully overcome. Mr. Colquhoun is one of those who have stressed the inexpediency of extinguishing lighting in the streets in an extreme effort to save coal, a trivial saving for which a heavy price might well have to be paid. One important point in this connection is the prejudicial effect on lamps and lanterns of being continuously unlit. Not only does their condition necessarily suffer, but it seems that the hooligans who make street lamps their target are apt to be exceptionally severe on those not actually in service. The proportion injured by missiles has been found to be very much greater than is the case with lamps in regular use.

Obituary

HAYDN T. HARRISON

It is with great regret that we record the passing away, at the age of 76 years, of Lt.-Cdr. Haydn T. Harrison, M.I.E.E., late R.N.V.R., one of the original members of the Illuminating Engineering Society and a Past-President. In the early days of the Society he took a leading part. As technical adviser to the Benjamin Electric, Ltd., and later to the Electric Street Lighting Apparatus Company, he was responsible for many new designs and much original work. He was regarded as an expert in photometry at a time when there were few indeed interested in such matters, and his position as a consulting engineer with a special knowledge of street lighting was almost unique. Of late years he suffered from a long illness and was able to pay little attention to technical matters, but his past services to illuminating engineering will not soon be forgotten.

A Conference of Secretaries?

The meetings of the Areas Joint Committee offer opportunities for the discussion of matters of common interest to I.E.S. Centres, but the matter should not stop there. There should be other unofficial contacts and exchange of views. In this connection a suggestion recently made tentatively by Mr. Fox, the secretary of the Sheffield Centre, that there should be occasional informal conferences between secretaries of Centres, seems to deserve attention. Anyone familiar with Centre activities must have noticed variations in procedure, not all due to local circumstances. Such topics as the selection of places for meetings, the arrangement of visits and social events, the development of special activities such as lectures to school children (or possibly the general public), contact with local authorities and universities, etc., seem worth discussion. Centres differ in practice, some being strong in some of these directions but weak in others. There must also be many points of detail in the actual execution of secretarial and committee work on which exchange of ideas would be profitable.

I.E.S. Birmingham Centre

Centre News Letter

In connection with what has been said above, attention may be drawn to one very useful step recently initiated by Mr. W. J. P. Watson, the Hon. Secretary of Birmingham Centre—namely, the periodical issue of a Centre News Letter, which seems well adapted to keep not only local members but officers of other Centres informed of what is taking place. No. 2, recently issued, contains about 1,500 words of duplicated matter. It refers to proceedings at the annual dinner and annual general meeting, recently noticed in these columns, and also to the papers recently read by Dr. J. H. Nelson on "Industrial Decoration," and by Mr. W. Allen on "Some Recent Trends in Daylighting." Mention is also made of the activities of the recently formed Group at Stoke-on-Trent, before whom Mr. H. W. Harvey recently read a paper on "Lighting in the Pottery Industry."

A Discussion on Illumination

A Discussion on Illumination, arranged by the Royal Society of Medicine (Ophthalmological Section), will take place at 5.15 p.m. on June 12, at the Royal Society of Medicine (1, Wimpole-street, London, W.1.).

The discussion will be opened by Mr. H. C. Weston, Dr. J. W. T. Walsh, and Dr. Dorothy Campbell. Demonstrations are also being arranged, and will precede the discussion, at 4.30 p.m.

We are asked to say that any I.E.S. members who may wish to attend the meeting will be cordially welcome.

Engineering and Marine Exhibition

I.E.S. Visit

The above exhibition, which used to be held annually at Olympia before the war, is this year being revived on the same site, and will take place during August 28 to September 13, 1947.

As in former years, the I.E.S. Council is being invited to pay an official visit, for which the date selected is Tuesday, September 9, when they will be entertained to luncheon. We are asked to say that any members of the Society who may also wish to attend the exhibition on the date specified, will be very welcome. Tickets will be obtainable in due course from the I.E.S. Secretary at 32, Victoria-street, London, S.W.1.

The Lighting of Highways

With special reference to Accident Prevention

By L. T. MINCHIN, B.Sc., M.Inst. Gas E., F.I.E.S.

(Summary of a paper read before the Institution of Highway Engineers.)

In the introduction portion of this paper Mr. Minchin referred specially to the analysis of traffic accidents, pointing out the extreme difficulty of gauging the advantage to public safety afforded by street lighting in statistical terms. There are many factors which make comparisons of accidents occurring by night and by day difficult; for example, the fact that people during the night period are usually more tired and less alert than during the day. The author quoted, however, some statistics published by the Royal Society for the Prevention of Accidents, and presented in graphical form on several occasions by Mr. J. S. Dow, which seem to afford interesting evidence of the effect of the black-out—for example, by showing that, in the absence of street lighting, accidents were most frequent on moonless nights.

Visibility and Background

There can, however, be little doubt that a considerable proportion of street accidents *are* due to defective visibility. An important factor in the lighting, also, is the giving of confidence to the driver. The visibility attainable even from the best artificial lighting installation is poor compared with that in daylight. Visibility in streets by daylight is largely by means of silhouette, and by artificial light very much more so. Much work has been done on the provision of even brightness on the roadway as a background to objects; but there are other backgrounds, e.g., the footway, buildings, and other vehicles. Road surfaces are in general shiny, and their reflecting qualities are altered when they become wet. Even brightness under all conditions is therefore scarcely possible and to secure moderate uniformity demands careful positioning of light sources. The extinction of certain lamps, e.g., as practised with a view to fuel economy, has naturally a very detrimental effect.

On long lengths of straight roads there is a tendency to achieve even brightness by increasing the candle-power at angles slightly below the horizontal, but the advantage is less evident on winding roads or on those occupied by dense traffic, apart from the increased glare liable to be caused by this method. The brightness of surrounding objects is of importance to pedestrians as well as to drivers. White paint is often valuable in promoting valuable contrast—for example, at bends in the road and in order to mark out the kerbway.

Codes and Specifications

Mr. Minchin then passed on to the discussion of various attempts to provide codes and specifications for highway lighting. Britain led the way with the first specification in 1927, but the basis thereof (minimum horizontal illumination) has since been superseded. Following the M.O.T. Reports in 1935 and 1937 a B.S.I. committee was set up to produce a new specification, but its work was interrupted by the war and has not yet reached finality. A revised version of the U.S.A. Code of Highway Lighting was published in February, 1946. It is frequently said that each case of street lighting requires expert treatment on its merits, and that any simple basis of measurement, which automatically tends to grade installations, is inexpedient. Yet the engineer needs *some* measurement by which to decide whether a given installation is adequate. The author assembled in tabular form the salient

points of the specifications and codes available and the data proposed in the M.O.T. Reports. The latter, whilst containing features of great value, should not, he suggested, be regarded as an authoritative gospel which has settled the problems of the public lighting engineer for a generation. Mr. Minchin criticised the method of merely stating a total light output per 100 feet of road without indicating how the light was to be distributed, and also the recognition of only two classes of road. The B.S.I. Committee, which is endeavouring to frame a specification, has since adopted a new criterion, the "acceptance number," designed to ensure that the candle-power at about 80° should not fall below a certain figure. The British practice, favouring a maximum candle-power at 80° to 85° differs from the American Code, which gives 75°, and on the Continent a maximum near 70° has been more usual. In this country the possibility of controlling the road surface, which has such an important effect on results, is not visualised, but the American Code does relate the desirable candle-power to the reflectivity secured, thus encouraging the adoption of a light-coloured material.

The sharp division, in the M.O.T. Report, of roads into two categories, evidently is apt to cause difficulty, owing to the large number of intermediate roads for which neither of the suggested systems of lighting is appropriate. The American Code, which visualises as many as 12 different classes, seems better in this respect.

Analysis of Two Accidents

In the latter part of his paper Mr. Minchin reverted to the question of road safety, which he illustrated by the case of a fatal accident to a pedestrian which occurred at a road crossing many years ago. It is possible that this pedestrian might have been distinguished in time if the background had been made brighter, e.g., by painting the railways between the roadway and a sports ground white, and by closer spacing of lamp-posts—the angle subtended at the eye by adjacent posts was about 40°, as compared with the maximum of 7° recommended by the M.O.T. Another frequent cause of accidents is the discontinuity which often occurs when a road passes from one administrative area to another. Here again an actual instance of an accident caused by the sudden change in the mode of lighting is recorded. Although, as has been stated, it is difficult to trace a direct relation between street lighting and safety, it is the author's belief that improved street lighting might reduce casualties very materially—by very much more than one per cent. Furthermore, many improvements could be made at relatively little cost.

A Good Home for Old Furniture

Those who have spare furniture for which they have had difficulty in "finding a home" because it had too many sentimental associations to be sold, could very well settle their problem by giving it to the Electrical Industries Benevolent Association for use in their home for old people at Broome Park, Betchworth, Surrey. Large sizes of furniture, such as are often inconveniently big in a modern house, will be welcome, as, of course, will soft furnishings, curtains, and floor coverings.

The Association is showing courage in tackling such an undertaking in the face of present-day difficulties, and deserves all possible help in this way; offers in the first instance should be communicated to the Secretary, 32, Old Burlington-street, W.1, so that further arrangements can be made for transport to the home itself.

Industrial Problems of Natural Lighting

A New Method of Research

By P. J. WALDRAM

Prior to 1939 practical interest in the problems of natural lighting was, for a variety of reasons, confined to a few (a very few) architects who had studied the technique of measuring daylight in order to qualify for acting professionally in connection with disputes over legal rights of light. These rights, however, rigidly excluded everything except the bare minimum of light sufficient for the ordinary purposes of habitancy, and our technical knowledge of the more or less special light required for most industrial processes was practically confined to unproven, if confident, guesswork. It still is to-day.

Pre-war, this was of no great importance. Daylight, as a rule, only meant glass area, and there was plenty of the cheap fuel necessary for the efficient alternative of artificial light. When war came, however, we were wholly unprepared for the urgent demands of industry for authoritative data which would enable manufacturers to decide between the contradictory demands, on the one hand of factory inspectors for that sufficiency of natural light under which alone the maximum production of vital munitions could be achieved, however efficient artificial light might be; and on the other, the need, only too obvious, to reduce to a minimum the risk and constant anxiety of removable, as compared with fixed, black-out, to say nothing of its difficulty and expense.

Owing to the complete absence of reliable data, it became necessary for the Government, through the Ministry of Home Security, to advise works managers to solve their own black-out difficulties by trial and error. This was done, but no records were kept, or at least none were published; and to-day, if one may judge by variations in published official recommendations, our ideas as to industrial requirements are no less hazy than they were in 1939. For example, even with regard to such an old, well-considered, and comparatively simple problem as the natural lighting of elementary school classrooms, standard in size and protected from excessive external obstruction by large playgrounds, there is a very marked difference between the published recommendations of Government Departments as to the ruling factor of the minimum light on the worst desk, expressed in daylight factor values, which determines window dimensions and story heights, very vital factors indeed in the total cost of the huge programme of new school buildings required by the raising of the school-leaving age.

The D.S.I.R. and the Ministry of Works, in a considered report* to fix the functional requirements of post-war schools at a minimum of 5 per cent., a tenfold increase of the British and Continental standard of 0.5 per cent. which has obtained for some 30 years past. The stated reason is that in 1937 a deterioration in the eyesight of children over the school years was medically reported, possibly due to a variety of causes, e.g., malnutrition. In the following year the regulations of the Ministry of Education reduced this by no less than 60 per cent. to 2 per cent. daylight factor; and even after this drastic reduction it has been alleged that the regulations are still too excessive to render possible the multi-story schools which are obviously essential in crowded towns. If this be the case, the prospect of keeping within the official estimate of £1,030,000 for new schools during the next 15 years is indeed bleak.

Any general resumption of post-war rebuilding may be dim and distant, but it is high time that we possessed something better than guesses as to industrial requirements which are as vital to national income as they were, in war, to national existence.

The following simple method of obtaining reliable data has been recommended recently to a Dominion Government faced with a heavy programme of industrial building. Perhaps it may be helpful.

Human reactions to variations in natural lighting are partly physical and partly physiological, but mainly psychological. It is therefore essential in any measurement of them to keep the individuals tested unaware that their more

* The Lighting of Buildings. Post-War Building Studies, No. 1, H.M.S.O.

or less voluntary reactions are being observed.

Fortunately, all ordinary interiors, if lit by windows on one side only, provide the most perfect opportunities for this to be done; because if the windows are fairly ample, and are reasonably free from external obstruction, the natural lighting as measured by daylight factors drops by some 90 per cent. from the win-wall to the back wall *without the occupants being aware of it.* Often, indeed, it is difficult to convince workers that any material difference exists provided the light near the back wall is adequate for the job in hand.

If, therefore, it is suggested or suspected that there would be greater output, or fewer rejects, if any given industrial operation involving visual acuity were performed in better light, all that is necessary is to arrange for operatives to perform it at workplaces of known daylight factor value at right angles to a window wall, change them round periodically and study the results. The data obtained should be of far-reaching value, and the cost practically nil.

Electricity in the Home

In a recent paper on this subject, read before the Royal Society of Arts on April 23, Miss Caroline Haslett analysed the needs of the home in regard to electricity and in relation to the fuel crisis. Miss Haslett put her finger on several weaknesses in the attitude towards saving electricity. There should be, for instance, differentiation between the use of electric current as a fuel (as an alternative to coal, gas or oil) and its use as a force (as an alternative to human energy). It was hard on the housewife in an all-electric home to be deprived of all applications of electricity for a considerable period of the day.

There is also confusion of thought regarding two aspects of the problem of electricity supply—the short-term problem of the lack of generating plant (which may, if the necessary plant is built, be solved within three years or so) and the long-term problem of the need for economy in the use of coal, which is of old origin. It is a far more efficient process to derive heat from electricity than from coal in the open grate.

Much of the paper was devoted to applications of electricity other than lighting. Miss Haslett emphasised, however, what is not widely realised, that lighting in general forms only a small part of the domestic load. She pointed out, for example, that if a 100-watt lamp were to be left burning in every room of a ten-roomed house the consumption in one hour would be only the same as that of a single one-bar electric fire for the same period. Actually, as a war-time social survey demonstrated, the amount consumed for lighting in the average home is very much less than it should be.

Mr. Applebee Visits America

Mr. L. G. Applebee, director of the Strand Electric and Engineering Co., Ltd., recently sailed on the Queen Elizabeth for New York, for liaison with American theatres. During his stay in America he will lecture to the American Illuminating Engineering Society and at Yale University on "Lighting in the English Theatre To-day." His visit is also in connection with the International Conference on Illumination to be held in Paris next year, and for which Great Britain is the operative committee on the subject of stage lighting.

Present Day Requirements for Street Lighting

By L. BLOCK

(The following is an abstract of an article which appeared in the *Swedish Kommunaltekn. Tidskr., 1944, 10* (1), 1-6)

Work on the development of street lighting has been severely handicapped during the war not only in countries where the black-out was imposed but also in non-belligerent countries where there was often a scarcity of material. During the war, however, the volume of traffic on the roads was considerably reduced, so that the lower standards of street lighting did not cause such great inconvenience as might otherwise have been expected. With the return to peace a considerable increase in the volume of traffic may be expected, and in what follows street lighting is discussed from the viewpoint of benefit to traffic under normal conditions.

Characteristics of the Eye

The sensitivity of the eye to light varies with the intensity of the light, due partly to alteration in the aperture of the pupil and partly because in the retina there are two different light-sensitive organs, the cones which function in normal intensities of light and the rods which alone govern the impression of light at low intensities. The cones are sensitive to colour, the rods, on the other hand, are not, hence seeing at low light-intensity depends wholly upon the effect of contrast between lighter and darker parts. This is of great importance because most street-lighting installations, for economic reasons, cannot be made so powerful that the eye will be able to arrange the visual impression by the cones in all weather conditions.

In motor driving the visual speed is extremely important. The time taken to interpret the visual impression of a lighted object depends upon both the intensity of light and the effect of contrast. The same holds for sharpness of vision, but in motor driving this is not of the same importance as visual speed. As a rule it is more important to be able to grasp quickly that there is an object on the carriageway than to be able to apprehend in detail its shape and appearance, although this, too, is naturally to be considered. Finally, the eye is very sensitive to glare, especially when in the dark-adapted state, i.e., brought to the greatest possible sensitivity. In consequence of the time required for adaptation the eye is also sensitive to variations in the intensity of light.

In planning street lighting installations regard must be paid to traffic intensity and requirements for driving speed. In general, the desire to be able to maintain a high speed is likely to be greater the larger the traffic volume, and it is therefore natural to adopt traffic intensity as a basis for classifying street lighting.

Lighting Power

The basis of all street lighting standards is "lighting power," which can be calculated mathematically. Since the lighting power on a street is closely bound up with the light supplied by the fittings, which in its turn is normally dependent upon the size of the lamp, completely different expressions for the lighting power required are found in the lighting specifications of different countries.

The most recent German lighting specification (1935) assigns a minimum value and a recommended value for both average illumination and illumination in unfavourable situations (i.e., with

Table I

	Average Illumination		Average Illumination in the most unfavourable situations	
	Min. value lux(1)	Calc. value lux.	Min. value lux.	Calc. value lux.
Streets and squares: with heaviest traffic in large towns	15	30	4	8
With heavy traffic	8	15	2	4
With medium traffic	3	8	0.5	2
With light traffic	1	3	0.2	0.5

(i) 1 lux=0.1 ft.-candles (approx.).

longer spacing and using non-cut-off type lanterns). The German specifications are reproduced in Table 1.

For new installations in Stockholm, introduced since 1926, a classification based on the use of incandescent lamps and a limited number of standard lamp fittings has been used. Table II shows the classification of roads in which requirements are stated in terms of watts per metre-length of street. The approximate average illumination has been added here to enable comparison to be made with the German standards.

Table II

Class	Type of Street	Effect per m.	Average Illumination
I	Representative streets and traffic centres	40—50 W.	15—20 lux.
II	Principal streets in central areas of towns	20—25 W.	7—8 lux.
III	Business streets, streets with normal traffic and ingress roads	10—12 W.	5—6 lux.
IV	Residential streets with rented houses ..	5—6 W.	2—3 lux.
V	Suburban streets with villas	1—2 W.	0.5—1 lux.

Ingress roads were included at first on a Class V basis, but were later transferred to Class III. Class I lighting is found only in a few places.

Recommendations made in England just prior to the outbreak of war (Final Report of the M.O.T. Departmental Committee on Street Lighting, 1937) stated that lighting on main roads should enable drivers to proceed with safety at a speed of 30 m.p.h. without the use of headlights. The recommendations appear to lay particular emphasis on speed of vision due probably to the increased speed of vehicles and the increased density of vehicles on the road. These recommendations also cover such matters as mounting height, spacing, number of sources, and light output of sources per unit length of road.

The American street lighting standards which were issued in 1940 prescribed lamp height as well as spacing and illumination in lumens. These standards are, however, particularly interesting because the required minimum lighting is prescribed in terms of lumens per metre length of street (1 m.m.) as a function of the traffic intensity (defined as the maximum number of vehicles per hour).

The American standards specify *inter alia* that lighting on rectangular and skew crossings shall be at least equal to the sum of the lighting on the intersecting streets. In installations erected in Stockholm 10 to 15 years ago it was often the practice to hang one lamp over the street crossing. If this lamp failed and was not immediately replaced by a new one, the street crossing was shrouded in gloom. Nowadays the lamps are hung at the openings of the streets instead. By this means the pedestrian crossings, which are the most dangerous places, are well lighted; the American requirements mentioned above are satisfied, and if one lamp fails, the street intersection is no longer dark.

As a result of the comparisons made above, it can be said that the standards embodied in Stockholm agree in the main with the most recent foreign ones. The regular increase in traffic intensity was, however, already so great before the war that even then it could have been adduced as a reason for raising certain streets into a higher lighting class. Street lighting installations erected before 1928 are also continually met with; they do not comply at all with modern standards, and should therefore receive priority of treatment when the supply of material again becomes normal.

Light Sources

In common with the standards of many other countries, an average life of 1,000 hours is expected of incandescent lamps when run at a prescribed voltage.

The overall costs for a given installation are composed of cost of current, cost of lamps, and cost of renewing lamps. The third item—exchanging lamps—cannot be neglected in street lighting. On the other hand, the cost of current per kW. for street lighting is generally appreciably less than for many other purposes, since the period of use is exceptionally long, in general about 3,800 hours per year. For street lighting it is therefore profitable to use lamps with a considerably longer life than 1,000 hours, and for this reason lamps of a higher voltage than the grid voltage are bought. If the grid voltage is 220 v., for example, lamps of 230 v. may be installed. The light is in this way 16 per cent. less, but the life of the lamp increases by 85 per cent. and the current consumption drops by 7 per cent.

Of late years electrical discharge

lamps have been employed to a much greater extent. Such lamps are seldom used on streets where it is desirable to be able to distinguish colours fairly accurately. On the other hand, they have been quite extensively used on ingress roads to towns where colour is relatively unimportant. The length of life is particularly valuable in street and road lighting, for the cost of changing the lamps is very high. Large mercury-discharge lamps may be expected to have an average life of 6,000 to 8,000 hours, and such lamps have been known to last for over 16,000 hours. In the laboratories of the lamp manufacturers intensive research is in progress, and it is hoped that a still better type of lamp, especially with regard to colour of the light, will be the outcome.

Colour Harmony

After the Annual General Meeting of the Colour Group, held at the rooms of the Royal Photographic Society on March 26, Dr. T. Vickerstaff, of I.C.I. Dyestuffs Division, gave an interesting and provocative lecture, entitled "A Statistical Investigation of Some Aspects of Colour Harmony," an investigation in which he collaborated with Mr. M. E. Clarkson and with Dr. O. L. Davies, of the statistics section of I.C.I.

Dr. Vickerstaff began with an account of previous work on the subject, including that of Drs. Parry Moon and Spencer, recently published in America. He said that a number of theories of colour harmony had been proposed at different times, starting with the simple theory that complementary hues formed a pleasing colour contrast. Moon and Spencer found four regions of wavelengths that gave harmony with a given hue and four regions of so-called "ambiguity" which gave unpleasing contrasts. Dr. Vickerstaff and his co-workers used a colour circle of 24 hues and tried out combinations of each hue with each of the other 23 taken in turn. They then asked some forty observers to assess the relative harmony of these combinations and applied a statistical analysis to the opinions expressed. They found that for the comparatively saturated colours used, complementary hues were not, in general, the most harmonious, although complementary combinations yielded the best harmonies under special conditions. If S represented the number of "steps" between the colours shown in combination, P the purity ratio and L the lightness ratio, then curves of the function SP/L^2 were found to be generally similar in trend to the curves of relative popularity, and Dr. Vickerstaff showed a number of curves which demonstrated this. In terms of the three Munsell variables, hue (H), chroma (C), and value (V), the harmony could be fairly represented by the function $C\sqrt{H/V^4}$ except in the case of yellow-greens. It therefore the case of yellow-greens. It therefore followed that complementary colours were most harmonious only when they were of the same value and chroma.

The lecture was followed by an interesting discussion, during the course of which some doubt was expressed as to the general validity of the results obtained in this and similar work owing to their probable dependence on such factors as the education and previous training of the observers used, on the pre-adapting conditions, and on the form of the pattern in which the colour contrast was presented.

At the Annual General Meeting of the Group which preceded the lecture, Mr. J. G. Holmes was elected Chairman and Dr. W. D. Wright was re-elected as Secretary. The Committee for the Session 1947-48 was elected as follows: Dr. D. R. Duncan, Messrs. L. C. Jesty and R. B. Morris, Drs. W. S. Stiles, J. W. Strange, and T. Vickerstaff.

The Jubilee of the Electron

Fifty years ago, on April 30, 1897, Professor J. J. Thomson (later Sir Joseph Thomson), at an evening discourse at the Royal Institution, made the first public announcement of the existence of the electron.

The electron is now playing an active and indispensable part in almost every home and in every industry—for wireless sets, television, and many systems of industrial control.

The Institute of Physics and the Physical Society, in collaboration with the Institution of Electrical Engineers, is arranging to mark this Jubilee by a series of lectures and other functions in London on September 25 and 26 and by an exhibition to be opened at the Science Museum on September 26.

Light and Colour and their Application

In an article in the *I.E.S. Lighting Review* (October, 1946), Mr. E. J. A. Weller, an architect and a member of the I.E.S. of Australia, points out that colour systems and complex colour terminology are merely means to an end, and that colour should be part of the everyday consideration given to the design of lighting schemes.

There is a danger, he says, that the present scientific emphasis on colour may create the impression that there is something new and previously unintelligible about colour, whereas it is really an indication of the growing realisation that colour qualities and their measured intervals may be precisely defined on a scale which enables rational discussion of colour, and can be employed to facilitate the planning and notation of colour schemes. All that such a scale means is that instead of referring to a colour as being a certain number on a paint manufacturer's colour card, and hoping that the same colour card is available to other parties concerned, it is possible to specify the colour as a fixed point on the Munsell or other colour scale. These colour scales are now becoming better known, even though they may not be generally available.

Colour Harmony

Merely to know the names of the notes on a musical scale, or even to recognise them, does not in itself produce musical composition; the same applies to colour. Certain devices, known as colour chords, have therefore been produced which may be considered as laws of composition and harmony, and which indicate, more or less automatically, colours which may be used together to produce colour harmony.

So far as the illuminating engineer is concerned, knowledge of the colour scale would be involved where standard colour nomenclature is employed in specifications incorporating the artistic conceptions of others. It will generally be sufficient, however, if he is aware of the effects which the colour in lighting mediums will produce, and if he realises that effective lighting cannot be produced unless there is absolute sympathy between the light quality, the colours of the surfaces illuminated, and the purpose for which the room or workshop is to be used.

Aids to Defective Vision

The *I.E.S. Lighting Review* also mentions an interesting experiment in the application of light and colour as a help to partially sighted schoolchildren. To supplement daylight, and to ensure a minimum of 35 lumens per sq. ft. during school hours, 12 twin 40-watt fluorescent units, fitted with diffusing glass, were installed in a classroom 23 ft. by 20 ft. The ceiling and walls were painted off-white, the dado pastel blue, while the chalkboards were green. Brown skirting boards and ivory architraves completed the scheme. With the minimum of daylight, the average illumination on the desks was 35 lumens per sq. ft., and, on the vertical chalkboards, 34 lumens per sq. ft. Under these conditions, it is stated, a marked improvement was observed in all students, some of whom were partially blind and had hitherto relied on Braille.

Testing of Plastic Mouldings

Plastics are likely to play an important part in many fields, and especially so in the electrical industry. A comprehensive survey of specifications bearing on moulded insulation was made by the B.S.I. in conjunction with other bodies some years before the war. Several specifications have already been published, and an interim report on the Testing of Finished Mouldings (B.S.1,330, 1946) has now been issued. This is available from the British Standards Institution (28, Victoria Street, London, S.W.1), price 7s. 6d. post free.

The Physical Society's Exhibition of Scientific Instruments and Apparatus

This year the Physical Society broke a long-established tradition by holding its annual exhibition of apparatus at Easter instead of in the New Year. The exhibition was open for four whole days, viz, from the 9th to the 12th April, and great care was taken, by issuing dated tickets, to avoid any repetition of the most uncomfortable crowding experienced on the last occasion. The organisation and the arrangements made for the convenience of visitors this year left nothing to be desired; the only hitch was an unavoidable delay in the production of the full catalogue due to the difficulties experienced by printers during the fuel-restriction period.

Trade Exhibits

The number of exhibitors was, if anything, larger than ever and it is therefore impossible to do more than mention those which were of direct interest to the research worker in photometry or to the lighting engineer.

On the lower ground floor Messrs. Evans Electroselenium, Ltd., showed the final production model of their handy little reflectometer, developed in conjunction with the Paint Research Station and capable of giving direct readings of the reflection factor of diffusing surfaces. By means of an ingenious focusing device, the reflection from a very small area of the surface could be measured quite readily. Messrs. Tintometer, Ltd., showed the Lovibond-Schofield Tintometer which incorporated the Rothamstead device for converting readings on the Lovibond scale to values expressed on the C.I.E. system.

Another exhibit of photometric interest was a comparator for measuring the brightness of aircraft instrument dials, both those treated with the familiar green radioactive luminous compound and the more recently introduced type treated with a luminescent material glowing a brilliant orange when irradiated with ultra-violet light. This was shown by Bryans Aeroquipment, Ltd., who had developed the instrument in collaboration with the National Physical Laboratory for the Ministry of Supply.

On the first floor Messrs. Siemens Electric Lamps and Supplies, Ltd., were showing various pieces of apparatus which might, perhaps, have found a more appropriate home in the research section of the exhibition. In addition to an array of special types of tungsten filament and discharge lamps, they showed the photometer used for measuring the brightness distribution across a discharge tube and apparatus for studying the waveform of the light given by tungsten filament and discharge lamps when run on a.c.

On the whole, the trade section did not include many exhibits which had a direct application in lighting practice. For example there was, probably for the first time, no exhibit of a visual portable photometer in this section and most of the photocells shown were applied to purposes other than the measurement of light. There were, of course, a number of exhibits of indirect interest, e.g., potentiometers and electrical measuring instruments of many different kinds, constant voltage transformers, spectrometers, and other optical apparatus.

Research Exhibits

In the research and educational section, on the other hand, there were a number of exhibits which call for notice. The Kodak research section showed a photoelectric spectrophotometer and a photoelectric trichromatic colorimeter. The latter had a particular application to the colour measurement of photographic papers and was therefore designed to deal with the difficult problem of measuring off-whites with accuracy. Another exhibit was of the apparatus used to determine the behaviour of camera shutters and a number of records showing the rate of opening and closing and the period of full aperture were exhibited. Messr. Ilford, Ltd., had on their stand an ingenious electrical computer for the solution of colour equations. Anyone who has had to carry out computations based on these equations will appreciate to the full the saving of time and mental effort effected by the use of such a machine.

The Research Laboratories of the British Thomson-Houston Company showed a very interesting type of photo-

cell designed for the measurement of the bactericidal radiation from a source giving ultra-violet light. This was designed to supersede the original method of measurement in which the brightness of a fluorescent surface exposed to the radiation was obtained by means of an ordinary photometer and the amount of the u.v. radiation was then deduced from a previously determined calibration. The photocell shown had a zinc cathode (although copper could also be used) and the sensitivity curve was such that, while the cell responded strongly in the region of wave-lengths responsible for the germicidal action, it was almost completely insensitive to daylight, except in this region. Thus measurements could be made in the presence of a considerable amount of non-germicidal radiation and no filtering was therefore necessary.

The General Electric Research Laboratories showed a cinema-studio arc lamp with double negative, reminiscent of the carbon arc standard investigated by Prof. MacGregor-Morris, but the object in this case was the prevention of noise during the taking of a sound picture. The exhibit of major interest to lighting engineers was, however, the cabinet showing a number of samples of fluorescent powders used in mercury tubular fluorescent discharge lamps. Three of the samples were of the three powders used in mixtures of different proportions, to give the familiar "daylight" and "warm white" tube. Then a further series of samples showed the development of the single powder used in the latest tubes of higher efficiency (see the March issue of LIGHT AND LIGHTING, p. 46). This powder consists of a tungstate activated with a mixture of antimony and manganese. One bright sample showed that activation with antimony alone gave a brilliant luminescence, but this was decidedly blue in colour. A neighbouring and much duller sample showed that activation with manganese alone gave a powder of very low luminous efficiency. Activation with a combination of antimony and manganese, however, gave a powder which was satisfactory both as regards brilliance and the colour of the emitted light. A number of samples containing these two substances in various proportions showed how increasing the amount of manganese resulted in a progressive reddening of the light emitted. This exhibit must have brought home, not only to the lighting engineer, but to all visitors to the exhibition who saw it, the vast strides in light production directly attributable to intensive and consciously directed research in a field almost completely neglected by the physicist until a comparatively few years ago.

Another exhibit which must have caused many of the more speculatively-minded to see visions and dream dreams was that of Prof. J. T. Randall, of King's College, London, who showed neon glow lamps excited by centimetre waves. It was somewhat uncanny to see a visitor pick up a small bulb lying, quite disconnected, on a table and to see it glow brilliantly as he brought it within range of the ultra-short-wave radiation.

The Admiralty Signals Establishment showed their method of testing the quality of performance of mirrors used in signalling apparatus by a traverse of the beam, using a photoelectric scanning device.

The Colour Group of the Physical Society had a very comprehensive series of exhibits illustrating the recently published Report on Defective Colour Vision in Industry (see LIGHT AND LIGHTING for January, 1947, p. 6). In the first room there were shown a large number of tests of colour vision. These included the various so-called "confusion charts" of which the Ishihara was probably the most familiar to visitors. Then there were the Nagel anomaloscope and other instruments depending on the mixture of coloured lights by the subject being tested. In a further room Dr. W. D. Wright's colour-mixing apparatus was shown, and visitors to the exhibition were invited to have their colour vision tested, if they so desired.

Discourses and Films.

As in previous year, a discourse by a specialist was given each evening. The most interesting to the lighting specialist was that given on the first evening of the exhibition by Dr. E. Lee, of the Admiralty Research Laboratory, Teddington, who took as his subject "Recent Infra-Red Developments." Dr. Lee was intimately concerned with the development in this country of the

apparatus used during the war for seeing by means of infra-red radiation. This "light" was, of course, invisible to anyone not equipped with the necessary apparatus for producing a visible image from the reflected infra-red, but the picture produced in the appropriate viewer was remarkably clear. A reference to a description of the system, published in the American *Illuminating Engineering* was made in LIGHT AND LIGHTING for March (p. 44).

The other three discourses were respectively on "Automatic and Manual Position Control Systems," given by Prof. A. Porter of the Military College of Science at Shrivenham, on "Recent Advances in Optical Science" by Mr. B. K. Johnson, of the Royal College of Science, and on "Recent Developments in Air Photography," by Mr. G. C. Brock of the Royal Aircraft Establishment, Farnborough.

A new departure this year was the inclusion in the programme of four films, which were shown at intervals throughout the period of the exhibition. One was a long film of the life of Lord Kelvin, shown by Messrs. Kelvin, Bottomley and Baird, Ltd., and Marine Instruments, Ltd. The other three were "shorts" dealing respectively with "Applications of Kinematography in Science," shown by the British Kinematograph Society, with "Phase-Contrast Microscopy of the Development of Sperm Cells of the Grasshopper," and a series of Time-Lapse Photographs of the Whole Sky, both shown by the Kodak Research Laboratories.

Both discourses and films proved, as usual, very popular, and, in fact, it is impossible to escape the impression that the exhibition might with advantage be visited by many more than those it is possible to accommodate in the Royal College of Science. It is readily understandable that there would probably be grave difficulties in the way of a scientific body like the Physical Society taking responsibility for an exhibition on a much more ambitious scale. The amount of voluntary work devoted to anything on even the present scale must be enormous, and this raises the question whether the time has come for the Physical Society to relinquish the task it has performed so creditably on so many occasions (this exhibition was the thirty-first sponsored by the society). Possibly the Department of Scientific and Industrial Research and the Central Office of Information, in collaboration with the society, could well take the responsibility for organising an exhibition on a still more ample scale and in a building which could accommodate, not only the professional physicist, but everyone interested in the applications of physics—and that, to-day, includes a not inconsiderable percentage of the general public.

"Lighting Service"

One notes with pleasure the publication of the first post-war number of "Lighting Service," the house organ of the Electric Lamp Manufacturers' Association of Great Britain, Ltd. It is a bright and varied production. Reference is naturally made to the very successful Lighting Design Courses, now being given in provincial cities as well as London. Mr. A. D. S. Atkinson, under the title "Powdered Light," explains the principles underlying fluorescent lamps, and there are illustrated descriptions of numerous gadgets such as the "Ideas to Remember" in the home, suggested by Mr. T. O. Freeth. "Surrounding Brightness" is dealt with by Mr. W. Robinson. In this connection some account is given of the Leicester exhibition in which the value of background brightness was strikingly demonstrated. Lastly there is a contribution by Mr. N. I. B. Harrison on "Seeing at School" in which the lighting of schoolrooms, the provision of "controlled brightness" and the value of fluorescent lighting as a supplement to daylight are discussed.

Amalgamation of Two Institutions

It was announced in the early part of 1946 that the Institution of Mechanical Engineers and the Institution of Automobile Engineers were considering amalgamation. Authority for this step has been given by the Privy Council and the appointed day for the amalgamation was April 13, 1947. Corporate members of the latter Institution now become corporate members of the former, which is initiating a special Automobile Division.

Lighting in Coal Mines

At a meeting of the I.E.S., Manchester Centre, on April 10 a lecture on the above subject was delivered by Dr. Wellwood Ferguson, whom the chairman of the Centre (Mr. Morrison) introduced as being not only one of our leading ophthalmic surgeons but also a member of the Institute of Mining Engineers and therefore very well qualified to deal with this topic.

In opening his address, Dr. Ferguson referred to the mechanism whereby the eye is used in daylight and darkness. He described the double photo-receptive mechanism of the eye, part of which is used where the light is good, whereas the other part comes into operation more and more as the light diminishes. It had been found that, apart from the blind spot which exists in each eye, a second blind spot was present in bad light. The brightness of the coal face in the average pit, the lecturer pointed out, is not sufficient to allow normal vision. On the average coal face (which has a reflection factor of only approximately 8 per cent.) the minimum illumination should be 0.4 foot-candles, The cap lamp, which is a comparatively new innovation, gives some improvement over the hand lamp, but the amount of light given is still too low.

The question of overcoming glare, to which miners are particularly sensitive, has also to be considered, and another important point is that pools of light followed by pools of darkness must be avoided by some means of even illumination.

The speaker then suggested that the low standard of pit lighting was the cause of miners' nystagmus, which was a source of considerable trouble and cost the country up to a million pounds a year. Figures for miners' nystagmus show that the average age of onset is 40-45 years and that it is most prevalent during years of depression. Tests for determining the amount of nystagmus were described, and the speaker concluded by quoting American practice and suggested that an increase of four to five times in the amount of light now in use in mines would seem to be necessary. and challenged the lighting industry to evolve a satisfactory system.

An interesting discussion took place, which was largely centred around the usefulness of the cap lamp. One speaker suggested that the regulations which had been enforced until recently causing the cap lamp to be fitted with a diffusing medium made this less efficient than the American type, which had a concentrated beam.

The speaker said he was aware of this, but unless there was a reasonable amount of general illumination the pools of light and glare from this type of cap lamp gave considerable trouble. The American system of mining, in which floodlights could be used, was referred to, but with the long wall working usual in this country, general lighting from the mains would seem to be the only satisfactory solution.

On the question of whitening pit props, etc., Dr. Wellwood Ferguson said that anything that could be done in this direction should be done.

Mr. R. M. Chalmers, head of the mining department of Wigan Technical College, paid tribute to the work of Mr. Ferguson on eye troubles among miners, and referred to cases in his experience where no nystagmus was present in pits using cap lamps, but considerable trouble in mines where portable safety lamps had to be used.

Another speaker asked why there was no nystagmus in Scottish pits, where acetylene lamps were used. In reply to this, the speaker said that they certainly experienced less trouble with these than with the portable lamps, and there might also be less nystagmus because some Scottish pits had always used some form of cap lamps. He suggested that it was possible that all miners in some coal fields suffered from nystagmus at some time.

The question of "vitamin A" starvation was also raised, and Dr. Ferguson referred to tests carried out in Sheffield, where volunteers were deprived of vitamin A for up to two and a half years. It was found impossible to cause complete absence of vitamin A in the system by this method. Yet in only two cases out of a very large number was it possible to find any decrease in dark adaptation ability from vitamin A starvation. It would appear, therefore, that vitamin A had no effect on nystagmus.

Dr. Ferguson said that there was no evidence that glare caused nystagmus, but a man suffering from nystagmus had an excessive susceptibility to glare and might take a very long time to become accustomed either to light or dark.

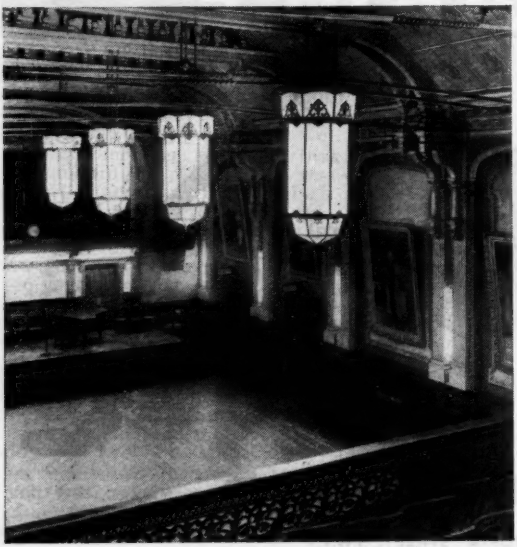
St. Catherine's Lighthouse (Fowey)

St. Catherine's Lighthouse at Fowey (Cornwall) is to have a new 25,000-c.p. light, visible, on most nights, over 20 miles away. The old optical apparatus supplied by Chance Bros. many years ago, is still as good as new. It has, however, been using a coal-gas light source operated by a German gas flasher. Now an electric incandescent lamp, flashed by an electric motor-driven mechanism, operating off the local supply, is to be substituted. Automatic switching on and off at dusk and daybreak is effected by a clock mechanism with solar compensation. The introduction of this new equipment in a lighthouse of old standing is a significant development. Doubtless many other essential but venerable lighthouses scattered about the world would benefit from more up-to-date equipment.

Fluorescent Lighting

The above picture illustrates the use of fluorescent lighting in the West End offices of the Norwich Union Insurance Society. The installation was carried out under the superintendence of the Society. Philips 80-w. fluorescent lamps were used, and G2620 fittings supplied by George Forrest and Son, Ltd.

Fluorescent Lighting in a Town Hall



The installation of fluorescent lighting in the Chatham Town Hall is of interest as an instance of the successful use of new lighting methods in an interior of traditional character. The main hall, here illustrated, was lighted by special pendants, each containing ten 5-ft. Osram 80-w. tubes. There were, in addition, 12 wall fittings of special design, also housing fluorescent lamps. Other special fittings were designed for the council chamber. In the main hall and council chamber 7-8 lumens per sq. ft. are provided—a great improvement on the previous value. The fittings were specially designed by the General Electric Co., Ltd., and were installed by the Kent Electric Power Co.